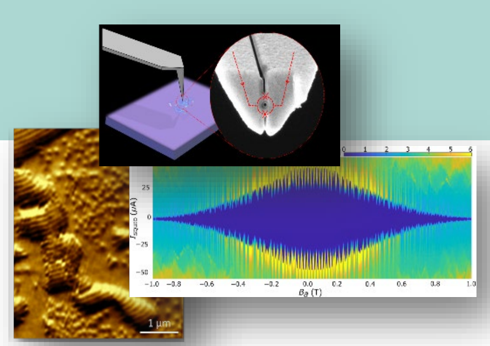
University of Basel
Department of Physics

Post-doc Position Available

Scanning SQUID microscopy of superconducting qubits and the quantum anomalous Hall effect



We seek a talented and ambitious **post-doctoral researcher** interested in applying sensitive nanometer-scale scanning superconducting quantum interference device (SQUID) magnetometers to image: 1) decoherence mechanisms, current flow, and dissipation in superconducting qubits and 2) bulk and edge currents, magnetic domains, magnetic switching, and the effects of film thickness in quantum anomalous Hall (QAHE) effect devices.

Superconducting circuits are a prime candidate platform for the realization of quantum computation. Significant progress has already been made, with demonstrations of quantum circuits containing 10s to 100s of qubits. To make further progress, however, a variety of microscopic effects must be addressed, such as vortex formation, quasi-particle generation, and two-level system defects, which lead to decoherence, as well as detrimental spurious fields, and crosstalk between qubits and control lines. These effects pose significant hurdles for the operation of large quantum circuits. As a result, effort is now dedicated to addressing these challenges via material engineering, fabrication methods, and circuit design. There is a pressing need to guide this work by spatially mapping circuit defects and decoherence mechanisms within quantum circuits.

The quantum Hall effect (QHE) represents the “gold standard” of primary resistance in electrical metrology. However, QHE devices based on GaAs heterostructures require challenging working conditions, i.e., temperature < 1.5 K, magnetic field > 10 T, and currents < 50 µA. Although the advent of graphene-based devices has relaxed the temperature and magnetic field requirements, it promises only incremental improvements and fails to address the need for operation at smaller magnetic fields, higher critical currents, and the ease of fabrication into large-area device geometries. On the other hand, the discovery of topological quantum materials circumvents the necessity for high magnetic fields and strict control of carrier mobilities. These materials can realise the QAHE at zero magnetic field, independently of carrier mobilities, which could lead to higher critical currents. Additionally, devices are relatively easy to fabricate into large geometries. Further improvements of QAHE devices require the application of advanced magnetic scanning probe microscopy to map current flow and magnetization configurations within the devices.

Highly sensitive scanning probe imaging using nanometer-scale SQUIDs offers a method for addressing both of these questions. Our nanoscale on-tip SQUIDs combine spatial resolution below 100 nm with extremely high sensitivities to magnetic flux, current flows, dissipated heat, magnetization configurations and magnetic defects. These quantities are exactly those that play crucial roles in both superconducting circuits and QAHE devices. The project aims be to map these quantities at both 4 K and in a new custom-built scanning probe system operating below 100 mK.

The Department of Physics and the Swiss Nanoscience Institute at the University of Basel offer a stimulating and collaborative environment with internationally recognized research groups active in both experimental and theoretical condensed matter physics. This project is part of the **Superconducting circuit engineering using scanning SQUID microscopy (SuperSQUID)** project. More information is available at poggiolab.unibas.ch.

Post-doc candidates with previous experience on superconducting circuits or low-temperature scanning probe microscopy are preferred. A Ph.D. in physics or a related field is required. Applications should include the candidate’s CV and at least 1 letter of reference. Applications and reference letters should be sent directly to Prof. Poggio (martino.poggio@unibas.ch) and Dr. Braakman (floris.braakman@unibas.ch).

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KANTON AARGAU

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POGGIO LAB

Department of Physics
University of Basel
Klingelbergstrasse 82
4056 Basel, Switzerland

CONTACT

poggiolab.unibas.ch
martino.poggio@unibas.ch
Tel: +41 61 207 37 61
Fax: +41 61 207 37 84

PROF. MARTINO POGGIO

ORCID: 0000-0002-5327-051X
ResearcherID: B-5821-2008
Google Scholar: Martino Poggio
arXiv: poggio_m_1